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Lab-on-a-disc platform with an integrated potentiostat for real-time drug release monitoring

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Drug release monitoring is commonly performed using instrumentation where large sample volumes are required for evaluation of a release profile [1]. However, in the initial stage of development and optimization, a device enabling measurement in low sample volumes, could be beneficial to accelerate the screening process of drug delivery systems.

Lab-on-a-disc (LoD) platforms have gained significant interest in both academic research and industry [2], since these systems require minimal instrumentation i.e. spinning motor for liquid transport and handling, consequently enabling the realization of simple, compact and integrated detection systems requiring low sample volumes for analysis. Additionally, the integration of electrochemical detection with microfluidics has several advantages [3], since both the electrodes and the instrumentation can be miniaturized, multiplexed and automated without losing performance [3,4].

We developed a LoD system with electrochemical sensors, electrodes, fabricated on a plastic support, placed in the detection chamber (Fig. 1a) and optimized the fluidic design to achieve controllable flow rates (Fig. 1b). The fluidic system was integrated with a custom build potentiostat (Fig. 1c), which was connected wirelessly to a smartphone and controlled via an app. Due to the wireless communication, there is no need for cables to connect the electrodes to the detector (potentiostat) and measurements can be carried out during spinning, in the flow. Consequently, drug release monitoring can be carried out in real-time electrochemically. The flow rate was measured optically (Fig. 1b), and the performance of the electrodes was evaluated in the flow. As it is shown in (Fig. 1d), the amperometric response changes corresponding to the spinning frequency of the disc.

As a case study, we evaluated the release profile of an electrochemically active model compound ferricyanide (Fic) from microcontainers. As it can be seen in (Fig. 1e), the released Fic from the microcontainers can be measured in real-time. The developed analysis unit will be used for the investigation of release profile when working with different pH-sensitive polymer coatings used for various microcontainer designs.

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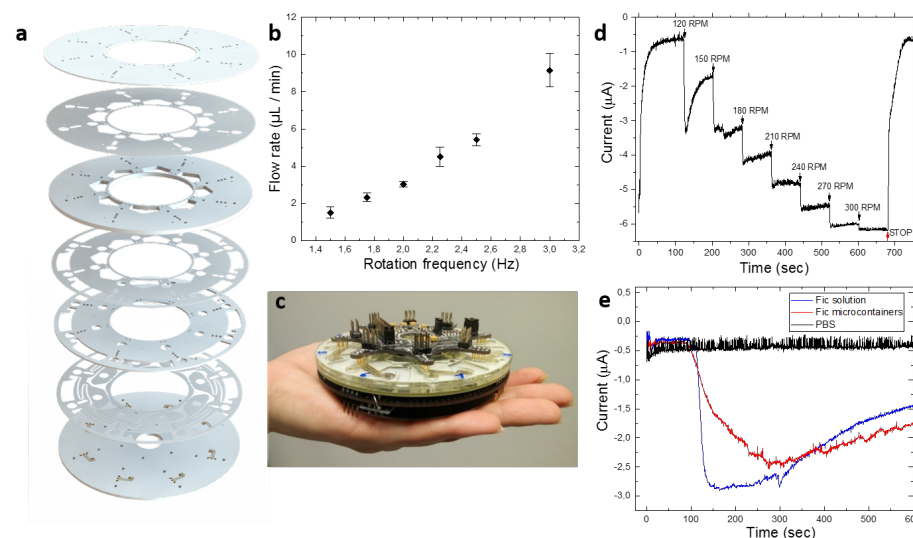


Fig. 1 a) Exploded view of the LoD system with electrodes; b) Flow rate vs. rotational frequency of the disc ($n=3$), measured optically using a MATLAB program; c) Photograph of the custom built potentiostat integrated with the LoD system; d) Amperometric detection of 2.5 mM ferricyanide (Fic) in phosphate buffer saline (PBS), pH 7.4 at an applied potential of -400 mV vs. Au pseudo-RE for different flow rates; e) Real-time amperometry response for Fic at an applied potential of -400 mV vs. Au pseudo-RE. The release of Fic from the microcontainers (quarter-chip suspended in 50 μL PBS) is slower when compared to the addition of 50 μL of 10 mM Fic solution to the loading chamber containing 150 μL PBS.